DS 9: Layer Properties I

Time: Wednesday 9:30–10:30 Location: SCH A 316

Invited Talk DS 9.1 Wed 9:30 SCH A 316

Flüssigphasen-Elektrochemie im Ultrahochvakuum unter XPS-Kontrolle — •Frank Endres — Institut für Elektrochemie, TU Clausthal

Ionische Flüssigkeiten zeichnen sich durch zwei interessante Eigenschaften aus. Zum einen haben sie sehr weite sog. elektrochemische Fenster, die Untersuchungen ermöglichen, die insbesondere in wässrigen Elektrolyten nicht möglich sind. Zum anderen haben sie sehr geringe Dampfdrücke, die die Untersuchung ionischer Flüssigkeiten unter den Bedingungen eines Ultrahochvakuums ermöglichen. In diesem Beitrag werden nun beide Ansätze kombiniert, indem elektrochemische Prozesse in ionischen Flüssigkeiten im Ultrahochvakuum mittels Photoelektronenspektroskopie untersucht werden. Ein Einblick in die Prozesse bei der elektrochemischen Reduktion von Tantalverbindungen, in die Prozesse bei der elektrochemischen Oxidation von Gold sowie in Disproportionierungsreaktionen bei der Reduktion von Galliumverbindungen wird gegeben.

Literatur:

F. Krebs, O. Höfft, F. Endres, Applied Surface Science 155130 (2022)

Z. Liu, O. Höfft, A. Gödde, F. Endres, Journal of Physical Chemistry C 125 (2021) 26793*26800

Z. Liu, O. Höfft, F. Endres, Journal of Physical Chemistry C 125 (2021) 24589-24595

DS 9.2 Wed 10:00 SCH A 316

Oxide thickness-dependent resistive switching characteristics of Cu/HfO_2/Pt ECM devices — •Taewook Kim[1], Tobias Vogel[1], Eszter Piros[1], Despina Nasiou[2], Nico Kaiser[1], Philipp Schreyer[1], Robert Winkler[2], Alexander Zintler[2], Alexey Arzumanov[1], Stefan Petzold[1], Leopoldo Molina-Luna[2], and Lambert Alff[1] — [1]Advanced Thin Film Technology Division, Institute of Materials Science, Technische Universität Darmstadt, Alarich-Weiss-Str. 2, 64287 Darmstadt, Germany — [2]Advanced Electron Microscopy Division, Institute of Materials Science, Technische Universität Darmstadt, Alarich-Weiss-Str. 2, 64287 Darmstadt, Germany

This study investigates the resistive switching mechanism and electrical conduction mechanism of the Cu/HfO_2/Pt MIM (Metal-Insulator-Metal) structure. In this study, we investigated the resistance switching characteristics of Cu/HfO_2/Pt samples. Specifically, we focus on changes in resistive switching characteristics as a function of oxide layer thickness. We noticed an interesting phenomenon of resistance switching property, that the reset switching occurs more sharply and abruptly in the sample with thick HfO_2 film. However, gradual reset is more dominant in the sample with thin HfO_2 film. Therefore, we devised the model (Thermally Assisted Electrochemical Mechanism) to explain the physical phenomenon. For better understanding, the conduction mechanism of Cu/HfO_2/Pt samples was also investigated. Cu/HfO_2/Pt has SCLC (Space Charge Limited Conduction) mechanism as the conduction mechanism. However, the mechanism is divided into several steps depending on the thickness of the oxide layer.

DS 9.3 Wed 10:15 SCH A 316

Substoichiometric conducting HfO_x phases as novel type of electrodes with a built-in oxygen vacancy reservoir for RRAM applications — •Philipp Schreyer[1], Nico Kaiser[1], Eszter Piros[1], Tobias Vogel[1], Taewook Kim[1], Despoina Nasiou[2], Leopoldo Molina-Luna[2], and Lambert Alff[1] — [1]Advanced Thin Film Technology Division, TU Darmstadt, Alarich-Weiss-Str. 2, 64287 Darmstadt, Germany — [2]Advanced Electron Microscopy Division, TU Darmstadt, Darmstadt, Germany

Hafnium oxide is an outstanding candidate as the active material in RRAM due to its performance and proven CMOS compatibility. In previous studies, we have shown that electrically conducting hafnium oxide phases can be stabilized by significant oxygen deficiency [1,2]. While so far only the physical properties of these structures have been investigated, we reproduced the phases in RRAM configuration to investigate the device properties. Resistive switching was found to be absent in all deficient in-vacuo processed samples. They show ohmic conduction, confirming the conducting nature of the substoichiometric phases. However, when exposed to air, a thin oxidized layer forms at the surface which stabilizes reliable resistive switching. Note that the oxidation process is self-limited leading to reproducible oxide thicknesses of a few nm. We suggest that the substoichiometric phases may act as second electrode with an oxygen vacancy reservoir that stabilizes oxygen vacancy filaments in ultrathin layers of near-stoichiometric HfO_2. [1] N. Kaiser et al., ACS Appl. Mater. Interfaces 14, 1290 (2022). [2] N. Kaiser, accepted. ACS Appl. Electron. Mater. (2023).